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SCIENCE RESOURCES STUDIES HIGHLIGHTS

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Pace of Retirements of Ph.D. Scientists and Engineers Shows Gradual Increase

Highlights

- The annual rate of retirements of Ph.D. scientists and engineers increased from 0.5 percent to 0.8 percent between the late seventies and mideighties. As a result, retired individuals comprised 4.8 percent of the doctoral scientist and engineer population in 1987, up from 3.1 percent in 1979. The average age of recent retirees was 65.
- In 1987, for the first time, over one-half (232,600 out of 451,400) of doctoral scientists and engineers were 45 years of age or older compared with about two-fifths in 1977.
- By field of doctorate, the highest proportions of retirees were in the physical and social sciences and in chemical engineering; no retirements were reported by Ph.D.s in computer science, a relatively new field.
- In 1987, the population of doctoral scientists and engineers was about 451,000. Throughout the decade, the labor force participation rate has continued to be approximately 95 percent and the unemployment rate about 1 percent.
- The employment of doctoral scientists and engineers rose at an annual rate of 4 percent between 1977 and 1987, but slowed in the latter half of the period. This slowdown was much more prominent in doctoral engineering fields than in science fields.
- The median annual salaries of doctoral scientists and engineers have increased in real terms during the eighties. Between 1983 and 1987, these salaries rose at an annual rate of 5.5 percent while growth in the Consumer Price Index (CPI) was 3.4 percent per year.
- Salaries of doctoral scientists lag behind those of doctoral engineers regardless of the number of years of professional work experience. For those with one year or less of experience, the ratio of scientist salary to engineer salary was 75 percent in 1987; for those with 20 to 24 years of work experience, the ratio was 88 percent.
- There has been little change in the geographic distribution of Ph.D. scientists and engineers over the 1977-87 decade. New England and the Middle Atlantic and South Atlantic regions accounted for about 44 percent of this population throughout the 10-year period. By State, California and New York ranked first and second, respectively, in both 1977 and 1987.

Population

In 1987, the population of doctoral scientists and engineers was about 451,000, an increase of 4 percent per year since 1977 when it was almost 304,000. Over this period, the annual rate of retirement[1] for doctoral scientists and engineers increased from about 0.5 percent between 1977 and 1979 to 0.8 percent during the 1985-87 period. The effect of this change was an increase in the proportion of the doctoral scientist and engineer population who were retired, from 3.1 percent in 1979 to 4.8 percent in 1987.

Although a small number of retirees were under 50 years of age, the vast majority (about 87 percent) of these individuals were 60 years of age or older. Individuals 70 years of age and older accounted for about 15 percent of this group of recent retirees. The average age was 65.

Retirements varied considerably by degree field. Retirees accounted for 6 percent to 8 percent of the doctorate-holders in the physical and social sciences and in chemical engineering compared with 3 percent to 4 percent of the doctorate-holders in the mathematical and environmental sciences, psychology, and in aeronautical, electrical, and mechanical engineering. No retirements were reported by individuals holding doctorates in computer science, a relatively new field.

[1]The retirement rate is the number of individuals who retired during a 2-year interval divided by the total population at the beginning of the interval; e.g., the number of individuals who retired between 1985 and 1987 expressed as a percent of the 1985 population.

Prepared in the S/T Personnel Characteristics Studies Group, Division of Science Resources Studies

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Age distribution. The age distribution of U.S. doctoral scientists and engineers has shifted. In 1987, for the first time, over one-half of all doctoral scientists and engineers in the United States were 45 years of age or older. Individuals 60 years of age or older accounted for 14 percent of the population, up from 10 percent a decade earlier. In contrast, about 12 percent of all doctoral scientists and engineers were under age 35 in 1987; the comparable proportion in 1977 was much greater—21 percent.

The aging effect observed among the total stock of doctoral scientists and engineers in the United States reflects several factors. Following World War II, the number of S/E doctorates awarded by U.S. educational institutions increased steadily, peaking in 1972. Since then, doctorate production in S/E fields among U.S. citizens and non-U.S. citizen permanent residents has declined by 14 percent in the sciences and 35 percent in engineering; and although doctorate degrees granted in engineering have increased in recent years, they still have not reached 1972 levels. Moreover, the age of new Ph.D. recipients in S/E fields has also been increasing. In 1977, the median elapsed time from baccalaureate to doctorate was 7.4 years; by 1987, this time span had increased to 8.5 years.

Geographic distribution. The geographic distribution of doctoral scientists and engineers, which is of interest to demographers, researchers, and regional planners, has shown only modest change during the past decade. In 1987, the New England, Middle Atlantic, and South Atlantic States accounted for 44 percent of the total (table 1), a level that has remained virtually unchanged since 1977. The Pacific region of the Nation has shown an increase, accounting for 17.0 percent of total in 1987, up from 15.7 percent 10 years earlier.

State rankings have also shown some change during the past decade. Although California and New York have continued to rank first and second, respectively, in number of Ph.D. scientists and engineers, other States have shown some change in rank. Among the top 10 States, Pennsylvania, Illinois, and Michigan have shown relative decline while Texas, Massachusetts, New Jersey, Maryland, and the District of Columbia have shown some gain. The proportion of individuals accounted for by the top 10 States has remained virtually unchanged at about 55 percent in both 1977 and 1987. Among these top 10, Maryland and Texas have shown the largest annual rates of increase during the 1977-87 period—5.2 percent and 5.0 percent, respectively—while Michigan and Illinois have registered the lowest: 2.7 percent and 2.4 percent, respectively.

Table 1. Population of doctoral scientists and engineers by geographic region: 1987

Geographic region	Number	Percent
Total	451,438	100.0
New England	33,851	7.5
Middle Atlantic	81,680	18.1
East North Central	64,658	14.3
West North Central	28,212	6.2
South Atlantic	83,017	18.4
East South Central	18,295	4.1
West South Central	35,689	7.9
Mountain	29,160	6.5
Pacific	76,876	17.0
U.S. Possessions	1,249	.3

SOURCE: National Science Foundation, SRS

Employment Characteristics

Market conditions. The potential of scientists and engineers at the doctorate level to enter the workforce remains very high and appears to have been unaffected by swings in the Nation's economy during this 10-year period. Throughout the decade, the labor force participation rate of doctoral scientists and engineers was approximately 95 percent. Doctoral scientists and engineers have little trouble finding work. In 1987, their reported unemployment rate of 1.1 percent was virtually unchanged from a decade earlier (1.2 percent in 1977). In addition, the unemployment rate of Ph.D. doctoral scientists and engineers was lower than rates for other segments of the U.S. workforce. In 1987, the overall unemployment rate in the United States was 6.2 percent[2] while for professional workers, it was 2.0 percent; the rate for scientists and engineers at all degree levels combined was 1.5 percent in 1986.

Field variation in unemployment rates was not large among Ph.D. scientists and engineers. The highest rate—1.4 percent—was reported by doctorate-holders in the physical and social sciences while the rate was only 0.1 percent for doctorate-holders in computer science and civil engineering.

Doctoral scientists and engineers also face little prospect of underemployment.[3] Their rate of 1.3 percent was one-half that reported by all scientists and engineers in 1986. Field variation, however, was considerable, ranging from virtually none for aeronautical and electrical engineers to 3.2 percent for social scientists.

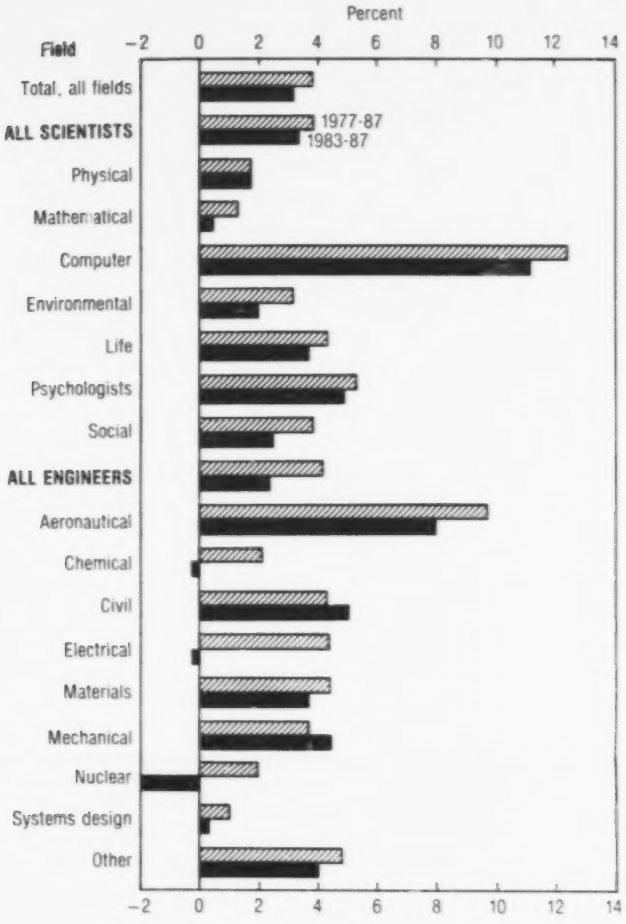
Employment. Employment of doctoral scientists and engineers reached about 420,000 in 1987, up from about 370,000 in 1983, and 285,000 in 1977. The growth in Ph.D. employment slowed in the latter half of the 1977-87 decade. While the annual rate of growth was about 4 percent for the total 10-year period, the rate dropped to 3 percent during the last four years. With the exception of Ph.D. civil and mechanical engineers, this trend was consistent across all fields (chart 1).

Among scientists, the fastest growing field was computer specialties. Between 1977 and 1987, employment of Ph.D. computer specialists increased at an annual rate of 12 percent, more than twice the annual rate of all other science fields. Nonetheless, this field only accounted for about one-tenth of the absolute growth in science fields overall; about one-third resulted from the growth in the number of life scientists.

[2]Department of Labor, Bureau of Labor Statistics, *Employment and Earnings*, Vol. 36, No. 1, January 1989, p. 172.

[3]Underemployment is defined as those who are working in a part-time job but seeking full-time work as well as those who are involuntarily working in a field outside of science or engineering.

Chart 1. Average annual employment growth rates of doctoral scientists and engineers by field: 1977-87



SOURCE: National Science Foundation, SRS.

Among engineers, the annual growth rate for the decade, about 4 percent, had slowed to 2.4 percent per year between 1983 and 1987. Much of the slowdown in employment of engineers resulted from declines in employment of chemical, electrical, and nuclear engineers.

Several divergent factors were involved. For example, the recession and the subsequent restructuring of the American chemical industry during the eighties contributed to slow growth in the chemical engineering field. Among doctoral chemical engineers, employment has shown little change, fluctuating around 7,000 throughout the eighties. In contrast, the employment trend among Ph.D. electrical engineers partially reflects degree production. While the number of U.S. citizens or foreign permanent residents earning doctorates in electrical or electronics engineering has risen relatively slowly during the eighties, the number of degrees earned by foreign temporary residents has shown sharp increases. Between academic years 1981/82 and 1985/86, the number of degrees earned by U.S. citizens and permanent residents rose from 607 to 672 while for temporary residents, the increase was 356 to 548. This trend is potentially significant since only an estimated one-half of individuals on temporary visas remain in this country.

Field. Variation in growth rates resulted in some shifts in the field distribution of doctoral scientists and engineers over the 1977-87 decade. A large majority of S/E doctorate-holders were scientists (84 percent) rather than engineers (16 percent) but within the sciences, there have been proportional shifts away from physical and mathematical sciences and towards computer specialties and life sciences. Among engineers, the fraction in aeronautical specialties increased while there was a decrease in proportion in the chemical subfield.

Employment sector. In 1987, academia continued to employ the most doctoral scientists and engineers, although the proportion has declined over the decade to 52 percent from almost 58 percent in 1977. In contrast, the share working in the industrial sector has risen from 25 percent to 31 percent. The fastest growing sector for doctoral scientists and engineers over the decade was industry. Employment in this sector increased at an annual rate of 6 percent, largely fueled by the 14-percent per year increase in the number of self-employed Ph.D. scientists and engineers. Among other sectors, above average growth was noted in State/local government and nonprofit organizations.

Primary work activities.[4] Research and teaching dominated the work activities of doctoral scientists and engineers; in 1987, almost three of every five reported one of these areas as their primary focus (chart 2). Activities, however, vary between scientists and engineers. Doctoral scientists were more concentrated in basic or applied research (32 percent), teaching (29 percent), or professional services (9 percent). In comparison, the top three activities for doctoral engineers were applied research (24 percent), R&D management (16 percent), and development (14 percent).

Salaries. Although employment opportunities for doctoral scientists and engineers have remained highly favorable during the past decade, increases in salary levels lagged behind increases in the cost of living between 1977 and 1983. Since then, however, this trend has been reversed. While the rate of growth in salaries of doctoral scientists and engineers was slower between 1983 and 1987 than between 1977 and 1983, it exceeded the increase in the CPI in the latter period. During 1983-87, the CPI rose at an annual rate of 3.3 percent compared to a rate of 5.5 percent in overall median annual salaries for doctoral scientists and engineers.[5]

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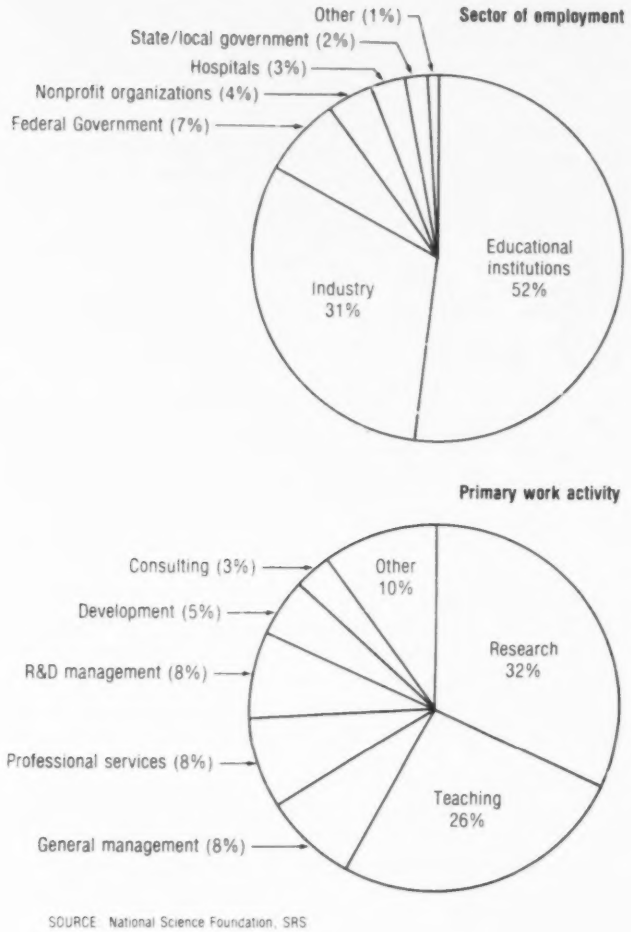
[4]Several new categories of work activity were added to the 1987 Survey of Doctorate Recipients. These additions have had an indeterminate effect on the distribution of these activities. As a result, comparisons over time should be viewed with caution. For a more detailed explanation, see National Science Foundation, *Characteristics of Doctoral Scientists and Engineers in the United States: 1987*, Detailed Statistical Tables (NSF 88-331) (Washington, D.C., 1989).

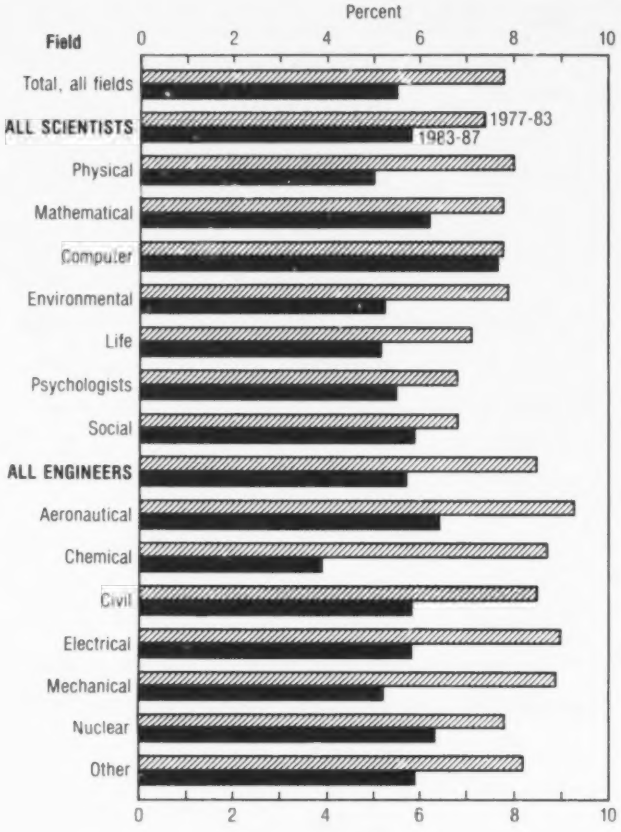
[5]Growth in the CPI is based on data from Council of Economic Advisors, *Economic Report of the President, 1988* (Washington, D.C.: Supt. of Documents, U.S. Government Printing Office, February 1988.)

Chart 2. Characteristics of doctoral scientists and engineers: 1987



SOURCE: National Science Foundation, SRS

Chart 3. Average annual growth rates in median annual salaries of doctoral scientists and engineers by field: 1977-87



NOTE: Median is computed for full-time civilians only.
SOURCE: National Science Foundation, SRS

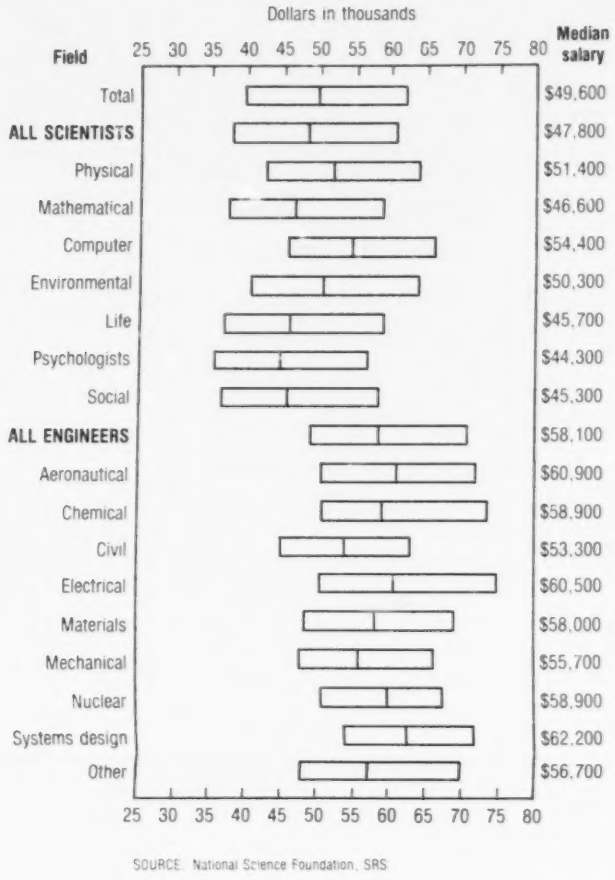
The slowdown in the growth rate of salaries during the 1983-87 period occurred in all S/E fields (chart 3). Least affected were computer specialists, whose salary levels rose at a rate of just under 8 percent per year. In contrast, salaries of chemical engineers increased at about one-half this rate (3.9 percent per year) during the most recent 4-year period.

The salaries of doctoral scientists and engineers show substantial field variability (chart 4). For example, among scientists, median annual salaries of over $50,000 were registered by computer specialists, physical scientists, and environmental scientists compared with salaries of about $45,000 for mathematical scientists, life scientists, social scientists, and psychologists.

Salaries of engineers exceeded those of scientists by a wide margin ($58,100 versus $47,800). With the exception of civil engineers, salaries in all engineering fields were higher than those for scientists; the highest median salary, reported by system design engineers ($62,200), was more than 40 percent higher than that for psychologists ($44,300).

Salaries also exhibited a high degree of intrafield variability. The interquartile range of salaries for all broad S/E fields amounted to about $22,000. Salaries in some fields (notably civil, mechanical, nuclear, and systems design engineering), however, showed a more restrictive range (about $17,000-$18,000) while the salaries reported by electrical engineers showed the greatest range ($24,500). The higher salaries noted for engineers is underscored by the fact that, with few exceptions, the lower quartile salaries for engineering fields were about equivalent to the median salaries in most science fields.

Chart 4. Interquartile range of annual salaries of doctoral scientists and engineers by field: 1987



SOURCE: National Science Foundation, SRS

Salaries of scientists are lower than those of engineers at all levels of professional work experience (table 2). The differential, however, declined somewhat over time. In 1987, the median annual salary of scientists with one year's experience or less was about 75 percent of that of engineers; with 20 to 24 years of experience, the differential had narrowed to about 88 percent. Although slight declines were seen at upper levels of work experience, salaries of scientists did not reach parity with those of engineers.

A similar pattern was seen with respect to the differential between men's and women's salaries. Overall, doctoral women's salaries were about 80 percent of men's salaries in 1987. Although this differential declined slightly with increasing or greater years of work experience, it did not disappear.

Table 2. Median annual salaries of doctoral scientists and engineers by years of professional experience: 1987

Years of experience	Total	Scientists	Engineers
Total	$49,600	$47,800	$58,100
1 or less years	$36,600	$34,200	$45,300
2-4 years	$37,000	$35,600	$44,800
5-9 years	$42,700	$40,900	$51,700
10-14 years	$48,600	$46,300	$58,300
15-19 years	$54,100	$51,500	$62,600
20-24 years	$58,100	$55,800	$63,600
25-29 years	$60,700	$59,400	$70,400
30-34 years	$63,900	$61,900	$72,500
35-39 years	$67,700	$66,200	$71,300
40 or more years	$68,700	$67,300	[1]

[1]No median computed for groups with fewer than twenty individuals reporting salary.
NOTE: Median salaries computed for full-time employed civilians only.
SOURCE: National Science Foundation, SRS

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Since 1973, the National Science Foundation (NSF) has collected information on the demographic and employment characteristics of doctoral scientists and engineers in the United States. These surveys are conducted for NSF and other Federal Government agencies by the National Academy of Sciences. The population surveyed includes individuals who reside in the United States or U.S. territories and who hold a doctorate in an S/E field or hold a non-S/E doctorate but are working in an S/E field. The sampling frame for the 1987 Survey of Doctorate Recipients comprised individuals who received their doctoral degrees from U.S. colleges and universities between 1944 and 1986; the overall sampling rate was about 13 percent.

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